Space Weather Technical Forecast

Issued on Friday, 11 February 2022 at 12:52 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Effects of 06 February CME continuing. Chance of coronal hole-linked G1 over weekend, with eventual Active electron fluence Likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours, with isolated low-level X-ray flares observed near the B/C flux boundary. There are potentially at least six sunspot regions on the solar disc at present, with a strong bias in population towards the western solar hemisphere. Of these potential regions, many are now nearing the western solar horizon, and as a consequence now appear unipolar - this includes AR2940 and AR2939 which now manifest as a Hax and Hhx, having been Cao and Cho respectively. AR2944 remained relatively unremarkable as a Bxi/Beta narrowly to the east, although the southwestern quadrant in general did see some other minor development, with newly-numbered 2945 (Bxi/Beta) developing here nearer the meridian, as well as other more fleeting detached pore regions coming and going (perhaps two others).

In the eastern hemisphere, activity was more limited, however another area seeing growth emerged near the eastern limb, numbered AR2946 and attaining Cro/Beta complexity. This left the final sunspot group AR2941 as an expansive but now decaying Fso/Beta group, spanning 17 degrees of solar latitude, but losing some intermediate spots and consolidating.

The sun is currently pockmarked in H-Alpha imagery by numerous filaments. One of the most noteworthy events of the period occurred to the immediate west of AR2945, with a dimming observed around 10/2030UTC perhaps related to a very small and faint filament disturbance in EUV imagery. this may be linked to an at least partially westward-directed CME now showing in Lasco imagery, with analysis yet to be carried out.

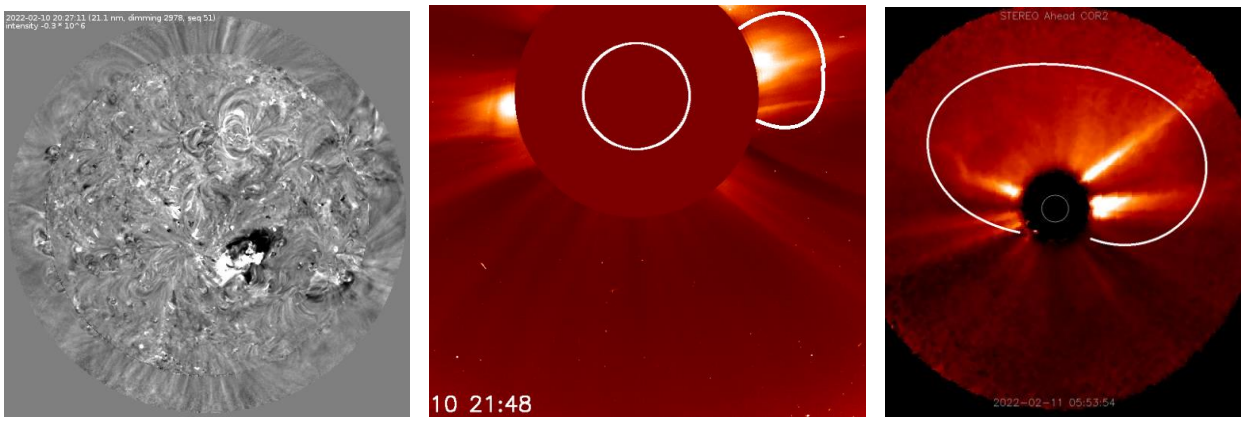

Figure 0: Left: SIDC ROB time-integrated AIA 211 sequence of southwest quadrant dimming; the possible resultant CME on Lasco C2 (middle). Right: A second CME from St A COR2's perspective, implying an emission location from near 150W given its partial halo-like appearance. These features will be fully analysed in due course.

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In addition to the above, a west-shifted partial halo is now also becoming visible on Lasco coronagraph imagery. This event has yet to be analysed (as with the aforementioned dimming CME) however this second event may be far-sided. No other Coronal Mass Ejections (CMEs) were in evidence in the period.

Solar Wind / Geomagnetic Activity: Earth spent much of the past 24 hours in a magnetic cloud-like environment, thought to be the (expected) tail end of the CME that left the sun on 06 February, with onset at L1 from 09/2013UTC. This enhancement did however see a noteworthy kick late in the reporting period around 11/0930UTC. This CME was modelled as three separate lobes in MOSWOC Enlil, and it is not impossible that this latest resurgence in some solar wind measures represents a further swipe from a component part, although this is not confirmed.

The 24-hour period as a whole mainly comprised a smoothly varying IMF vector, which spent much of the first half of the period strongly anti-aligned with Earth's field (to maximum geomagnetic effect), later transitioning to become co-aligned with time, a trait that strengthened after 11/0930UTC. Bt peaked late at 17nT, with Bz varying between an early -13nT and an eventual +17nT.

The solar wind speed, as measured by DSCOVR at L1 showed a declining trend from early highs near 450km/s, reaching 375km/s during the UTC morning of Friday before rallying at the 24-hour period's end. The solar wind density was mostly within typical mid-single figures, but saw a late kick to become slightly elevated. The phi angle showed a slow drift, mainly within a negative sector (towards the sun).

The net result of the above solar wind measures showed a strong dependence on Bz, with provisional Kp peaking at '5o' in the 15-18UTC interval, with a '5-' following in the 18-21UTC interval before eroding to become quieter through the UTC morning of Friday, with the late resurgence falling short of G1.

A roughly 30nT-deflection in the H-component of magnetic field was seen at Hartland was observed, centred about 11/1030UTC, although this generated only slight geomagnetic activity given the orientation of the IMF vector.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2MeV) was initially above the High threshold, peaking at 7543pfu at 10/1410 UTC before geomagnetic activity resulted in Normal Background and then Moderate activity for the remainder of the period. The corresponding 24-hour integrated electron fluence values were above the Active (1e8 integrated pfu) threshold at first, but with a declining trend, ending the day at 1.27e8 integrated pfu at 10/2359UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to remain Low through the next four days. Sunspot regions are expected to be in a state of flux in the period, with numerous departures and arrivals, and confidence is therefore low.

Solar Wind / Geomagnetic Activity: There are unassessed CME candidates on current imagery, with updates to follow in future guidance.

The only CME in the current forecast is therefore the 06 February CME - ongoing since 09/2010UTC. This has undergone a resurgence late in the current reporting period, but ought to ease in earnest later on day one, leaving an ambient solar wind environment at first into day two,

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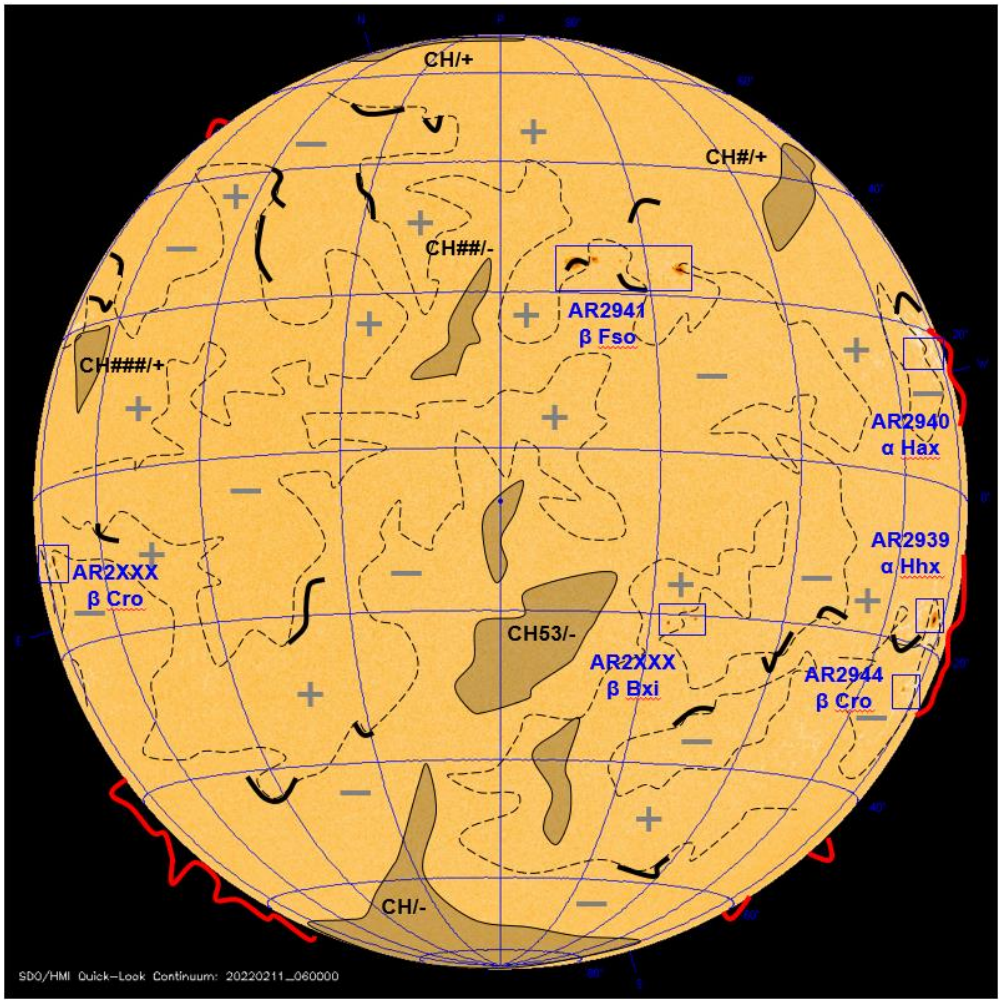
Saturday 12 February. The high speed stream from coronal hole 53 is then expected to arrive, perhaps later Saturday and lasting on into Sunday 13 February, with speeds perhaps eventually reaching 600km/s.

Geomagnetic activity is expected to start Active due to residual 06 February CME effects - especially given the slightly elevated density and IMF, with a Slight Chance of G1. Mainly Quiet conditions should follow for a time, perhaps becoming Active again later Saturday and into Sunday 13 February, with isolated G1/Minor Storm intervals on onset.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at Background levels, but with a daily Slight Chance of S1 given any significant flares from the regions in the western hemisphere.

The high energy electron forecast is of particularly high uncertainty, but overall a twin peak in risk of Active fluence should bookend the coming four days - initially from the recent waning Active environment and into the new week following a high speed stream from CH53.

Figure 1. Solar Analysis Valid 11/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Effects from the 06 February CME - ongoing since 09/2010UTC showed a resurgence in the past 24 hours. The cause of this is open to debate, however MOSWOC modelling treated the initial eruption as three separate lobes, with one largely on the ecliptic and two directed below. It may be that this latest discontinuity is an arrival of one of these more narrowly glancing features, although the Bz component was largely unaffected during the change (i.e. was still a relatively smooth sweep through Bz, Bx and By components). Whatever the cause, this CME should wane through the remainder of day one, leaving an ambient solar wind environment at first into day two, Saturday 12 February.

The high speed stream from coronal hole 53 is then expected arrive, perhaps later that same day, and lasting on into Sunday 13 February, with speeds perhaps eventually reaching 600km/s. This appears to be at odds with current STEREO A MAG and PLASTIC measurements, which suggest a high speed stream-like feature is imminent, perhaps around the turn of the coming UTC day Friday into Saturday. This may be related to a faint high-latitude feature on the disc, as CH53 appears a little too far eastward at present for this to be the cause.

Geomagnetic activity is expected to start Active due to residual CME effects given the slightly elevated density and IMF. This relies on there being no return to strongly negative Bz, with this part of the magnetic cloud assumed to have passed, giving only a Slight Chance of G1 in the remainder of Friday. Mainly Quiet conditions should follow for a time, perhaps becoming Active later Saturday and into Sunday 13 February, with isolated G1/Minor Storm intervals on onset.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	40	30	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil, but note the unassessed candidates.

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Figure 2: the past 3 days in solar wind speed at L1 (top), density (middle) and IMF (bottom). Note the onset of the 06 February CME at 09/2010UTC; the relatively smooth magnetic cloud-like structure from 10/1200UTC; and the uptick at 11/0930UTC.

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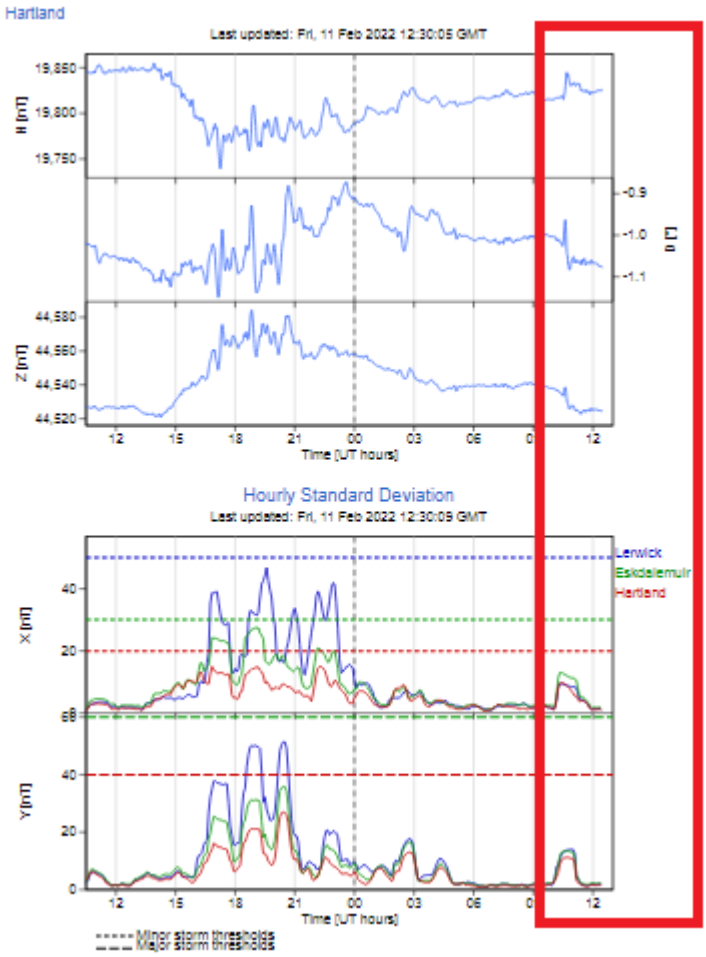
Figure 3: BGS Hartland magnetometer H, declination and Z components, showing discontinuity relating to the uptick in solar wind measures shown in figure 2. Also shown is the HSD measurement, a measure of energy deposited by the field.



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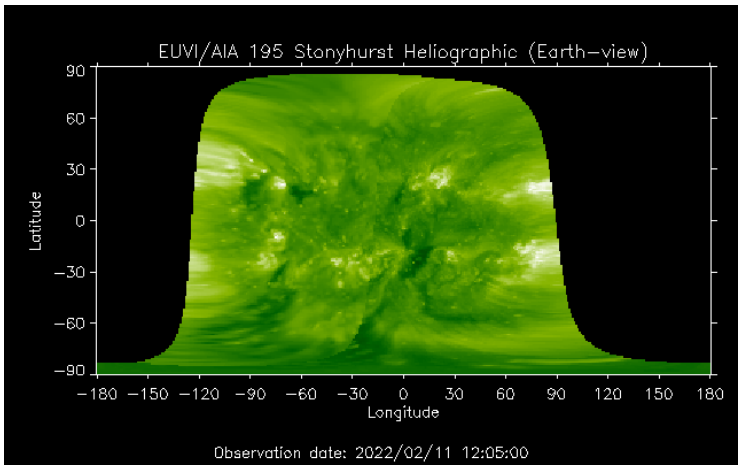
Radio Blackouts - X-Ray Flares:

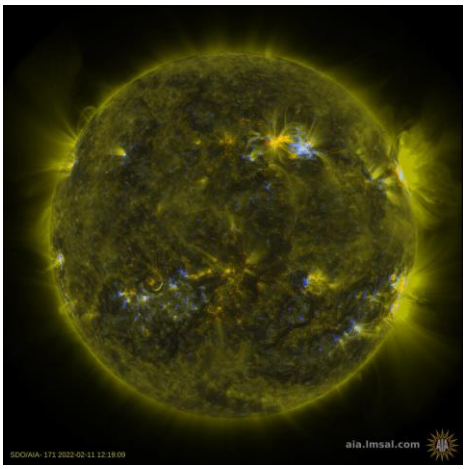
The balance of sunspot groups should enter a state of flux over the forecast period. Returning regions Ex-2935 and Ex-2934 should greet the end of the UTC weekend and the new working week respectively, with both appearing on far-side soundings and EUV imagery, suggesting at least some survival(s) here. This is in contrast to the depopulation expected to occur of the current western limb, with AR2939, AR2940 and AR2944 all expected to leave the disc. This is all happening in the context of a changing disc, with the largest group, AR2941 decaying as an Fso, with this in contrast to currently small newly-developing regions (including AR2945 and 2946) adding further uncertainty to the mix.

The X-ray forecast on balance is unchanged for now, however confidence in the continuation of the current state of affairs is now very low.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: (Left) The whole sun in false colour cylindrical projection, showing a possible returning region near N30E100. Note also the bright departing spots on the western limb. (Right) An AIA 171 and HMIBC composite showing flux as being largely skewed to the western hemisphere and especially near the western limb.





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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at Background levels.

Solar radiation storms are unlikely in the period, however, the crowded western limb gives rise to a Slight Chance of S1 should any of these regions flare, with the poor viewing angle now hampering analysis of the many regions here. This risk should begin to wane into the new working week UTC as they more comfortably distance themselves from the western limb on the far side.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The electron forecast now carries particularly high uncertainty, with current populations very marginal for exceedence of the 24-hour Active fluence threshold in the context of a passing transient and a recent Active period. A degree of recovery is probable in the next 48 hours or so as geomagnetic activity settles down post-CME, with counts then probably again dented for a time by the arrival of CH53 over the UTC weekend.

With a solar wind speed potentially approaching 600km/s from CH53, eventual exceedence late in the period appears Likely, leading to twin peaks in risk of Active bookending the coming four days.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	60	40	40	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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